United States of America.

Bowker, R. R. United States Government Publications, July 1, 1890–June 30, 1895. Compiled, under the editorial direction of R. R. Bowker, by J. H. Hickox. (Reprint of Appendix of American Catalogue, 1890–1895.) New York, 1896. 10 by 11. 60 pp.

United States Navy Department, Hydrographic Office. Illustrated Cloud Forms for the Guidance of Observers in the Classification of Clouds. C. D. Sigsbee, Captain United States Navy, Hydrographer. Washington, 1897. 5½ by 9¼. 16 plates.

District of Columbia.—Report of the Health Officer of the District of Columbia for the year 1896. Washington, D. C., 1896. 8vo. 277 pp. 6 charts, 30 by 30.

Michigan.—Twenty-second Annual Report of the Secretary of the State Board of Health of the State of Michigan for the fiscal year ending June 30, 1894. Lansing, 1896. 8vo. cciv, 526 pp.

Proceedings and Addresses of the Third Annual Conference of the Health Officers in Michigan, held at the State Laboratory of Hygiene, State University, Ann Arbor, Mich., July 16–17, 1896. Lansing, 1896. 8vo. 139 pp.

New Jersey.—Seventh Annual Report of the Board of Directors of the New Jersey Weather Service for the year 1896. Trenton, 1897. 8vo. 240 pp. 4 maps, 10 by 14.

THE EARLY USE OF WIRE IN KITE FLYING.

By S. P. FERGUSSON (dated Blue Hill Observatory, April 9, 1897).

After the account of the high kite ascension at Blue Hill on October 8, 1896, was published, I received a letter from Mr. Thomas H. Butler, of Providence, R. I., giving an account of some experiments in kite flying made by him and his friends in England about forty years ago. Mr. Butler stated that iron wire was employed as line, and sometimes 2 or 3 miles were let out and taken up by the kites. Strong electric shocks were experienced by those holding the line.

As Archibald, of England, had received credit for being the first, in 1883 and 1884, at the suggestion of Sir William Thomson, to make use of steel wire for kite line, Mr. Butler's letter was interesting, especially in regard to the early use of wire, and to the altitudes reached. I wrote him asking for further information, and he corresponded with some friends in Bradford, England, who sent him two clippings from the *Bradford Observer Budget*, and a letter, which Mr. Butler has kindly sent me. I copy Mr. Butler's letter (1) and the newspaper extracts (2 and 3) below, as also (4) Mr. Pyrah's letter of January 30, and append a few additional remarks (5):

(1) *Letter from Mr. Thomas H. Butler, of Providence, R. I., to S. P. Fergusson.*—Please find enclosed a little information toward proving my previous statement regarding the early use of wire as a kite line. * * * For a five-foot tall kite, we used small cane or brier for the bow with a strong lath for the perpendicular or backbone as I will call it, and good twine. But for a giant kite such as you would require the bow wants to be made of lancewood such as used for archery purposes, and the backbone of strong but lighter wood, and in the place of twine use thick, strong wire and you could make a pretty light frame big enough to lift a man. It is a pleasure to see this style of kite go up. When she strikes the wind as soon as she is let loose she is as graceful and pliable as a bird. I believe a giant kite constructed after the above design would reach a higher altitude than has been reached yet with a great deal less expense and trouble. * * *

(2) *Extract from Bradford Observer Budget of February*, 1897.—In reply to your correspondent who writes for information in respect to flying kites with wire in Bierly Lane, Bradford, I beg to inform you that I remember that Mr. Joshua Law had a wire mill close to Bierly Lane, and he had at that time three men in his employ, namely, George Walker, Solomon Shires, and Christopher Firth, and I have seen these men fly kites with two and a half miles of wire more than fifty years ago; and if a piece of string was tied to the end of the wire nearest the hand, on touching the wire quite a strong electric shock was felt. The Mr. Butler who writes to you from Olneyville, U. S. A., I have known from childhood, but he being quite twenty years my junior may not remember the above. I am, etc., WM. WEBSTER.

Black Swan Hotel, Boroughbridge, February 4, 1897.

(3) *Extract from the Bedford Observer Budget of February*, 1897.—I saw the letter of the 4th of February, 1897, from Mr. Webster, Black Swan Hotel, Boroughbridge, and it was quite correct. I have known him ever since he was a boy, and all his family, too. Kite flying with wire was practised at Dudley Hill by workmen from Mr. Joshua Law's wire works 55 years ago, and the kites were sent up with 2½ miles of wire attached to them. In 1842 and 1843 I saw kites sent up and drawn in again, and the electric shocks from them were something terrific. I have seen sparks of fire when the wire was touched with a knife blade, and men and boys severely shaken and some fall to the ground. I have a friend at Low Moor, 60 years of age, who informs me that he used to fly kites with wire 50 years ago at Mr. Dan. Bateman's wire works, and he has seen men fly kites 4 feet long and 2 feet 8 inches wide, with tails attached 20 yards long, and a lantern with a big candle at the end, so that you could imagine the kite was a little star. He also assures me that kite flying was practised 80 years back at Mr. Bateman's works. When Robert Stephenson, the great engineer, was a boy, his father bought him a donkey to ride to school, and while pursuing his journey he used to fly kites with copper wire a mile long; that was 60 years ago. (See his life, page 126.) For fun he used to touch the head of the donkey with the wire, and of course the donkey knew about it. Kite flying has been practised in England with iron wire, steel wire, and copper wire. Hoping this will satisfy our American friends who think that kite flying with wire is of recent introduction, I am, etc., JOHN PYRAH.

8 Heeles street, Tong street, near Bradford.

(4) *Letter of Mr. Pyrah addressed to Mr. Butler.*—Having seen your correspondence on kite flying with wire, I will give you facts which I witnessed fifty-six years ago. The works of Mr. Law's, wire drawer and card manufacturer, were at Goose Hill, now called Rooley Lane, near Bradford, in Yorkshire, and their workmen tried kite flying for a whole summer by the White Heart publick house in my presence in 1842, fifty-six years ago. I was then fourteen years old, and lived at the place. I was sadly shaken myself when I was asked to touch the wire, and a great many were laid on their backs by the electric currents; at last they were ordered to give over before some one was killed. I saw it strike fire sparks when touched with a penknife or a button. This statement could be verified by many. I am rather surprised to hear that scientific men such as you name should not have known and published this before 1884. (Dated Bradford, January 30, 1897.)

(5) *Remarks by S. P. Fergusson.*—The kite described by Mr. Butler is very simple, consisting of a rather stiff upright stick, over the top end of which a flexible stick or cane is bent in the form of a bow. Cords from the ends of the bow extend to the lower end of the upright, and the covering is secured to the bow and to these cords. The bridle is attached at two points on the upright near the middle of the kite. The tail appears to be of cord, to which are attached short pieces of cloth or paper. Archibald's kites differed from this pattern in that they were diamond shaped, having no bow at the top, and in the use of a cone tail. The wire used by Mr. Butler and his friends was ordinary iron wire, about the diameter of a large pin.

Mr. Rotch has found in the English Mechanic of September 8, 1876, a letter from A. Willan, describing some electrical experiments with kites, from which the following is quoted:

> I have always flown my electric kites simply with this iron wire (the best Swedish), any length of which can be obtained at places where the combs for wool-carding engines are made. * * * The wire I use is No. 23, B. W. G., but with a light wind a thinner size might with advantage be used. I have it wrapped on a large wooden bobbin and fixed in a wooden frame, so that it winds up with a handle. Care must be taken to avoid "kinks," which invariably result in a breakage of the wire.

From the above it appears that the use of wire for kites is not new; with the long lines employed, considerable altitudes were probably reached.

[It should be noted that Espy and the Franklin Kite Club used wire for flying their kites about 1836 in Philadelphia. See under Notes by the Editor.]

CLOUD MEASUREMENTS AT BLUE HILL.

(By H. H. CLAYTON, dated February 28, 1897.)

At Mr. Rotch's request I send herewith an example of my method of calculating the heights of clouds from the positions of their shadows. The first method we used was by a formula similar to one given by Professor Abbe in describing Feussner's method (see page 322 of his Treatise on Meteorological Apparatus and Methods), and which reads as follows:

$$z_1 = b \sin (a_1 \pm 180^\circ - a_3) \tan h_1 \operatorname{cosec} (a_1 - a_2)$$

In which z_1 is the height of the cloud above Blue Hill; b is the distance to the cloud shadow, as measured on a map of the surrounding region; a_1, a_2, and a_3 are the azimuths of the cloud, sun, and cloud shadow, respectively; h_1 is the observed angular altitude of the cloud.

This, however, was only a partial solution since it gave only the height above one station and no criterion for determining the accuracy. Hence it was soon abandoned and the following modification of the method was adopted. The formulæ are not essentially different from those of Ekholm and Hagstrom (see page 315 of the above-mentioned Treatise).

When a cloud shadow is seen in a favorable position the azimuth and angular altitude, a_1 and h_1, of the cloud are immediately measured with a theodolite; then the azimuth and angular altitude of the sun, a_2 and h_2, are measured; these are to be corrected when necessary for the slight change in the position of the cloud and sun during the time elapsing between the first and second observations; then the azimuth, a_3, and distance, b, of the cloud shadow are measured, as seen on the ground when the first observation was taken. The distance is taken from a map, of which we have a number, detailed, accurate, and on a large scale for the region around Blue Hill.

A moment's consideration will show that the measurement of the azimuth and angular altitude of the sun from Blue Hill takes the place of an observation of the sun and cloud with a theodolite at the position of the cloud shadow. For if an observer were at that point and looked toward the cloud he would find it exactly in the direction of the sun, and since the rays of the sun are practically parallel, he would get the same angular altitude and azimuth as that measured by observing on the sun from Blue Hill. Hence, by making the measurements of a_2 and h_2 from Blue Hill alone, we get the same results as if we had observers looking at the cloud simultaneously from the two ends of a base line, and the formulæ for calculating the results are the well-known trigonometrical relations:

$$A_1 = a_1 - a_3; \qquad z_1 = b \sin A_2 \operatorname{cosec} A \tan h_1$$
$$A_2 = a_2 - a_3; \quad z_2 = c + z_1 = b \sin A_1 \operatorname{cosec} A \tan h_2$$
$$A = a_1 - a_2; \qquad z_m = \tfrac{1}{2}\,(z_1 + z_2 - c)$$

This formula gives the mean altitude of the cloud above Blue Hill (z_m) from the results calculated from the two ends of a base line drawn from the lower station or shadow to a point below the upper station; c is the difference in level between the stations, and must be read off from the map by means of the contour lines, if the country is not quite level. The relations of the angles to each other in the above formulæ, and the agreement of the calculated heights z_1 and $z_2 - c$, furnish criteria[1] for determining the accuracy of the observations and for preventing errors which might arise, for example, from taking the angular measurements on one cloud, while by mistake using the shadow of another.

The following table gives the results of measurements made on a cumulus cloud on May 19, 1896. The heights in the second to the fifth columns were determined parallactically by two observers with theodolites observing simultaneously at the ends of the base line. The mean of their four results is given in the sixth column. The height given in the seventh column was determined a few minutes later (at

	Theodolite method.				Mean.	Cloud shadow method.
Time	$8^h\ 27^m$	$8^h\ 28^m$	$8^h\ 29^m$	$8^h\ 30^m$	....	$8^h\ 51^m$
Calculated height in meters	961	967	972	950	963	958

8:51 a. m.) by means of cloud shadows; evidently the two methods give practically the same results.

The base of the nearly uniform stratus or nimbus, measured by kites, is, I think, lower as a physical reality than the broken sheets of the same clouds, the only kinds which permit of measurement with theodolites.

Example illustrating the method of computation by the above formulæ.

Distance of shadow b=4,482 meters; shadow below Blue Hill c=44 meters.

Time,	$2^h\ 53^m$ p. m.	log tan h_1	9.6286	Z_2	1,543 meters
Cloud.	S. cu.	log sin A_2	9.7230	c	44 meters
$A_1=a_1-a_3$	106.0°	log b	3.6515		
$A_2=a_2-a_3$	148.1°	log cosec A	0.1737	Z_2-c	1,499 meters
$A=a_1-a_2$	42.1°	log sin A_1	9.9828	Z_1	1,485 meters
h_1	22.8°	log tan h_2	9.3803	Diff.	14 meters
h_2	13.5°			Z_m	1,492 meters
		log Z_1	3.1718		
		log Z_2= Z_1+c	3.1883		

[1] See note by the Editor on "Cloud Heights."

THE MECHANICS AND EQUILIBRIUM OF KITES.*

A monograph prepared by C. F. Marvin, Professor of Meteorology, U. S. Weather Bureau, submitted with the approval of Prof. Willis L. Moore, Chief of Weather Bureau, in competition for the "Chanute Prize" offered by the Boston Aeronautical Society.

ANNOUNCEMENT OF PRIZE.

Octave Chanute, Esq., ex-president of the American Society of Civil Engineers, generously offers the prize herein described.

Under date of May 27, 1896, he writes to the Society as follows:

"I herewith enclose $100, and authorize the Boston Aeronautical Society to offer this sum as a special prize for the best monograph on the kite, giving a full theory of its mechanics and stability, with quantitative computations appended.

"This prize to be awarded by judges appointed by the Society. It may be withheld one year in case no sufficiently complete monograph is handed in.

"To explain the latter reservation, it may be suggested that the following points need consideration:

"1. The resolution of all the forces acting upon an ordinary kite with a tail; *i. e.*, the wind pressure upon its surface, its tail, and its string, and the weight (gravity) of these various parts. The resulting equilibrium, or the diving, spinning round, or glancing sideways, and how the forces act which restore the balance. State the position of the center of gravity, center of pressure, and best point of attachment for the string, with numerical example.

"2. Give the same elements for the tailless kite, distinguishing between the Malay, the Japanese or Chinese, the Bi-polar, the Hargrave, and the Fin (Boynton) kites. Indicate also what are the general principles upon which each group of the tailless kites depends for its stability.

"3. What effect is produced by changes in the point of attachment of the string, and what is the pull thereon with various positions and with various strengths of wind.

"4. What is the difference in effect between the kite string and the attraction of gravity on the mass of a soaring bird.

"Sincerely yours, O. CHANUTE."

Competitors for this prize are requested to have their essays typewritten, and to send them in on or before November 15, 1896.

Address Secretary of the Boston Aeronautical Society, P. O. Box 1197, Boston, Mass., U. S. A.

CONTENTS.

	Section.
Introduction	I
Definitions and axiomatic statements	II
General statement	III
Forces acting on kites in general	IV
Circumstances of equilibrium and motion	V
Explanation of the flight of kites	VI
Abnormal flight of kites	VII
Effects of changes in wind and position of kite	VIII
Conditions of stability and steadiness of kites	IX
Numerical data	X
The mechanics of the kite string	XI
Properties of the catenary	XII

I.—INTRODUCTION.

Since our purpose is to present in full a theory of the mechanics and stability of kites in general, it will be well at the outset to clearly define the essential and fundamental conception that we consider to be conveyed or suggested by the word kite. Furthermore, the behavior of kites, however diverse in character and detail, results from the action and reaction of a small number of well known natural forces. Some of the forces that we must consider act upon the kite itself, while others, in a wholy independent manner, act upon the string or line employed to restrain the kite. Very important limitations to the attainments of which kites are capable arise wholly in consequence of the action of forces upon the string. Under these circumstances it will be most logical, after defining the kite, to consider without regard to any particular or specialized form of kite, those general and fundamental principles of physics and mechanics that underlie the action of all kites and study that relation of forces which is essential

*The above monograph, by Professor Marvin, was awarded the "Chanute Prize" by the judges appointed by the Boston Aeronautical Society, which society has also submitted it for publication in the MONTHLY WEATHER REVIEW.